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On the Composition of Errors from Single Causes of Error. By CHAS. H. KUMMELL, of U. S. Coast and Geodetic Surv., Wash. D. C. [Rep. from *Astronomische Nach.*, *N*o. 2460-61.

The Intersection of Circles and the Intersection of Spheres. 24 pp. By BENJAMIN ALVORD, Brig. Gen. U. S. A. [Reprinted from *Amer. Jour. of Mathematics*, Vol. V, No. 1.]

In this Memoir Gen. Alvord solves geometrically all the questions in Intersections, by the same principle, in effect, as was used by him in the memoir on "The Tangencies," publish'd in the Smithsonian Contribution, Vol. 8, 1855.—The question in Intersections is reduced to one in tangencies and orthogonals. There is an evolution throughout the whole investigation from the principle of the radical center, that is; the radical axes of three given circles intersect each other in a point, called the radical center, which is also the center of the circle orthogonal to said circles. The radical center of four spheres is found in like manner.—All questions in Spheres are reduced to those in Circles.

Naming the General question (without considering the various cases), the following are the problems solved, and the number of solutions to each.

1. To draw a circle to cut each of three given circles at the same given ang., 8 solutions.
2. To draw a sphere to cut each of five given spheres at a given angle, 16 "
3. To draw a circle to cut each of five given circles at the same angle (angle being unknown), 96 "
4. To draw a sphere to cut each of five given spheres at the same angle (angle being unknown), 640 "

It is believed that the last two questions have never been solved geometrically heretofore; nor was it known that there were so many solutions. Some of them are imaginary. Thus in circles the required circle may often not intersect either of the given circles, but will be situated in a similar manner toward each.

Prof. Arthur Cayley, F. R. S., who happen'd to be in Baltimore when the paper was offered, appends a valuable note at page 10.

Mr. Marcus Baker in the ANALYST for July, 1877, page 128, proposed the last question for solution. R. J. Adcock, in the ANALYST for September, 1877, page 158, gave the equations for solution of that question, and Thomas Craig, in ANALYST for Jan. 1880, p. 13, gave an analytical solution by the method of determinants.

If Steiner, who proposed the last two questions in the 1st Vol. of Crelle, 1826, ever solved them, or if he published such solution, such fact is unknown to the best accessible authorities.

ERRATA.

On page 176, Vol. IV, *dele* $\sqrt{2}$ in last term of the value of I_5.
" " 164, line 8, of Vol. IX, for "persons" read insured persons.
" " 178 of Vol. IX, lines 5 and 8 from bottom, insert sign of integration after $\times$ at the beginning of each line.
" " 3 of Vol. X, line 4 from bottom, for lower limit of int. read ax.
" " 10 line 7, for $6a$ read $6a^2$.
" " 12 " 4, for $\sin x$ under the sign of integration read $\sec x$.
" " 13 " 16, insert minus sign after the sign of equality.
" " 13 " 17, for "This", read These.
" " 14 " 5, for the exponent "$n+2$", read $n-2$.

In Table " " 120 of Vol. IX, in $\sqrt{2}$, after the 124th dec., read 360558507372126441 and in $\sqrt[3]{2}$ omit the last 13 decimals; in $\sqrt{8}$, the 23rd decimal is 7; in $\sqrt{10}$, the 102nd dec. is 5, and in $\sqrt{15}$, the 24th decimal is 5.